

## PATENT COOPERATION TREATY

PCT

NOTIFICATION OF THE RECORDING  
OF A CHANGE(PCT Rule 92bis.1 and  
Administrative Instructions, Section 422)

From the INTERNATIONAL BUREAU

To:

MADDERN  
Level 1  
64 Hindmarsh Square  
Adelaide, S.A. 5000  
AUSTRALIE

Date of mailing (day/month/year) 08 June 2001 (08.06.01)	IMPORTANT NOTIFICATION
Applicant's or agent's file reference 18322 WGM:NH	
International application No. PCT/AU00/01142	International filing date (day/month/year) 20 September 2000 (20.09.00)

## 1. The following indications appeared on record concerning:

☒ the applicant      ☐ the inventor      ☐ the agent      ☐ the common representative

## Name and Address

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## State of Residence

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## 2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:

☐ the person      ☒ the name      ☐ the address      ☐ the nationality      ☐ the residence

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Teleprinter No.

## 3. Further observations, if necessary:

## 4. A copy of this notification has been sent to:

<input checked="" type="checkbox"/> the receiving Office	<input type="checkbox"/> the designated Offices concerned
<input type="checkbox"/> the International Searching Authority	<input checked="" type="checkbox"/> the elected Offices concerned
<input type="checkbox"/> the International Preliminary Examining Authority	<input type="checkbox"/> other:

The International Bureau of WIPO  
34, chemin des Colombettes  
1211 Geneva 20, Switzerland

Facsimile No.: (41-22) 740.14.35

Authorized officer

Eugénia Santos (Fax 338.87.40)

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## PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

## NOTIFICATION OF ELECTION

(PCT Rule 61.2)

To:

Commissioner  
 US Department of Commerce  
 United States Patent and Trademark  
 Office, PCT  
 2011 South Clark Place Room  
 CP2/5C24  
 Arlington, VA 22202  
 ETATS-UNIS D'AMERIQUE  
 in its capacity as elected Office

Date of mailing (day/month/year)

22 May 2001 (22.05.01)

International application No.

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18322 WGM:NH

International filing date (day/month/year)

20 September 2000 (20.09.00)

Priority date (day/month/year)

20 September 1999 (20.09.99)

Applicant

CHURCHETT, Andrew et al

1. The designated Office is hereby notified of its election made:



in the demand filed with the International Preliminary Examining Authority on:

05 April 2001 (05.04.01)



in a notice effecting later election filed with the International Bureau on:

2. The election ☒ was

was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO  
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INTERNET COOPERATION TREATY  
**PCT**  
INTERNATIONAL PRELIMINARY EXAMINATION REPORT  
(PCT Article 36 and Rule 70)

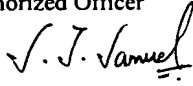
14

REC'D 27 APR 2001
WIPO PCT

Applicant's or agent's file reference 18322	<b>FOR FURTHER ACTION</b>	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416).
International Application No. <b>PCT/AU00/01142</b>	International Filing Date (day/month/year) 20 September 2000	Priority Date (day/month/year) 20 September 1999
International Patent Classification (IPC) or national classification and IPC  <b>Int. Cl. <sup>7</sup> H02P 7/28; G05B 5/00</b>		
Applicant  <b>BRITAX RAINSFORDS PTY LTD et al</b>		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 3 sheets, including this cover sheet.  
☐ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).  
  
These annexes consist of a total of sheet(s).

3. This report contains indications relating to the following items:
- |      |                                     |   |
|------|-------------------------------------|---|
| I    | <input checked="" type="checkbox"/> | Basis of the report   |
| II   | <input type="checkbox"/>            | Priority  |
| III  | <input type="checkbox"/>            | Non-establishment of opinion with regard to novelty, inventive step and industrial applicability  |
| IV   | <input type="checkbox"/>            | Lack of unity of invention  |
| V    | <input checked="" type="checkbox"/> | Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement |
| VI   | <input type="checkbox"/>            | Certain documents cited   |
| VII  | <input type="checkbox"/>            | Certain defects in the international application  |
| VIII | <input type="checkbox"/>            | Certain observations on the international application   |

Date of submission of the demand 5 April 2001	Date of completion of the report 17 April 2001
Name and mailing address of the IPEA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustalia.gov.au Facsimile No. (02) 6285 3929	Authorized Officer  <b>SERINEL SAMUEL</b> Telephone No. (02) 6283 2382

**I. Basis of the report****1. With regard to the elements of the international application:\***

- ☒ the international application as originally filed.
- ☐ the description,        pages , as originally filed,  
   pages , filed with the demand,  
   pages , received on    with the letter of
- ☐ the claims,        pages , as originally filed,  
   pages , as amended (together with any statement) under Article 19,  
   pages , filed with the demand,  
   pages , received on    with the letter of
- ☐ the drawings,        pages , as originally filed,  
   pages , filed with the demand,  
   pages , received on    with the letter of
- ☐ the sequence listing part of the description:  
   pages , as originally filed  
   pages , filed with the demand  
   pages , received on    with the letter of

**2. With regard to the language, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.**

These elements were available or furnished to this Authority in the following language which is:

- ☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

**3. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, was on the basis of the sequence listing:**

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

**4. ☐ The amendments have resulted in the cancellation of:**

- ☐ the description,        pages
- ☐ the claims,        Nos.
- ☐ the drawings,        sheets/fig.

**5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).\*\***

\* Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).

\*\* Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report

**V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement****1. Statement**

Novelty (N)	Claims 1-11	YES
	Claims Nil	NO
Inventive step (IS)	Claims 1-11	YES
	Claims Nil	NO
Industrial applicability (IA)	Claims 1-11	YES
	Claims Nil	NO

**2. Citations and explanations (Rule 70.7)**

The present invention relates to a vehicle mirror motor control used in moving a mirror between an in-use position and a parked position, in particular to a circuit which effectively turns off electric current to the motor as the mirror reaches the end of its intended travel when being folded back or moved to an operative position.

To achieve this a motor control circuit for a direct current electric motor has a pair of direct current inputs supplied respectively from negative and positive current sources. The direction of travel of the rotor of the motor is determined by the polarity of the current supplied to it. The motor control circuit of this invention comprises a pair of substantially identical unipolar control circuits. Each of the unipolar control circuits being connected between a respective current source and a current input to the motor wherein a respective unipolar control circuit is adapted to operate said motor in one of said two directions.

Such an arrangement is not disclosed in any of the citations either singularly and /or in combination the subject matter of the invention defined in the claims. Therefore the claims are considered novel and inventive.

The claims also have industrial applicability.

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization  
International Bureau



(43) International Publication Date  
29 March 2001 (29.03.2001)

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G05B 5/00

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(21) International Application Number: **PCT/AU00/01142**

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20 September 2000 (20.09.2000)

(74) Agent: **MADDERNS**; Level 1, 64 Hindmarsh Square, Adelaide, S.A. 5000 (AU).

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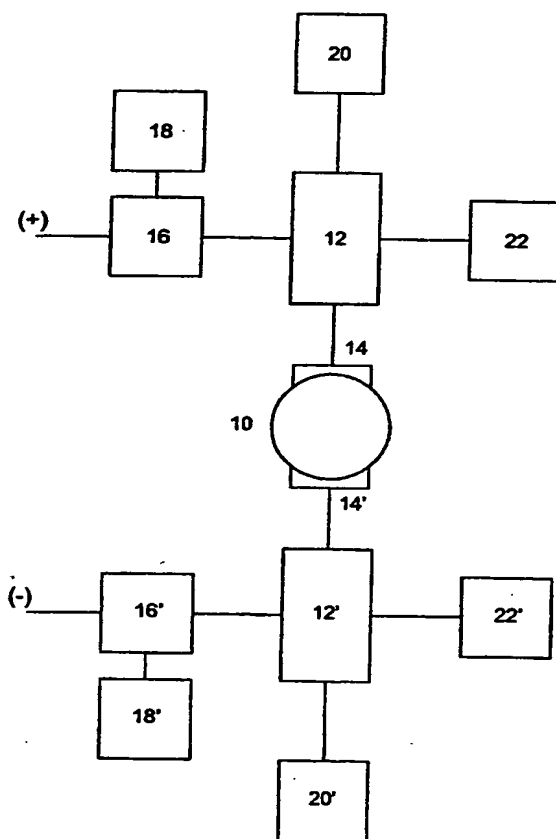
(81) Designated States (national): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

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(84) Designated States (regional): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European

[Continued on next page]

(54) Title: **DIRECT CURRENT MOTOR CONTROL CIRCUIT**



(57) Abstract: A motor control circuit for a direct current electric motor has a pair of direct current inputs supplied respectively from negative and positive current sources. The direction of travel of the rotor of the motor (10) is determined by the polarity of the current supplied to it. A new motor control circuit comprises a pair of substantially identical unipolar control circuits. Each of the unipolar control circuits being connected between a respective current source and a current input to the motor wherein a respective unipolar control circuit is adapted to operate said motor in one of said two directions. Each of the unipolar control circuits comprises a solid state switch (12) located between a motor current input and the source of direct current. The degree to which said solid state switch allows current to flow to the motor is controlled by an input bias signal to the switch. Current limiting for adjusting the input bias signal according to the current flowing through said motor is provided in one way of controlling the motor movement. The switch adjusts the input bias to the solid state switch such that less current flows through the motor when a predetermined period of current limiting has occurred. Also a current detection can be used to detect the magnitude of current being drawn through the motor and if the magnitude exceeds a predetermined level for a predetermined time, the input bias signal to the switch can be reduced.

Rec'd PCT/PTO 19 MAR 2002

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patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

**Published:**

— *With international search report.*

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU00/01142

**A. CLASSIFICATION OF SUBJECT MATTER**Int. Cl. <sup>7</sup>: H02P 7/28; G05B 5/00

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

IPC: H02P 1/C; G05B 5/C; G02B 7/C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

IPC: AU AS ABOVE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPAT: Direct current, bidirection, unipolar, circuit, polar+, automo+, mirror+

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5,952,802 A (PIMLEY) 14 September 1999 ✓ Whole document	1-11
A	US 5,530,327 A (VECCHIARINO) 25 June 1996 ✓ Whole document	1-11
A	US 5,514,940 A (OKAMOTO) 07 May 1996 ✓ Whole document	1-11

☒ Further documents are listed in the continuation of Box C ☒ See patent family annex

\* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an

inventive step when the document is taken alone  
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&amp;" document member of the same patent family

Date of the actual completion of the international search

10 October 2000

Date of mailing of the international search report

18 OCT 2000

Name and mailing address of the ISA/AU

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## INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU00/01142

**C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4,798,967 A (YAMANA ET AL) 17 January 1989 Whole document	1-11

**INTERNATIONAL SEARCH REPORT**  
Information on patent family members

International application No.  
**PCT/AU00/01142**

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member					
US	5952802						
US	5530327	DE	69312889	EP	603509	JP	6206497
US	5514940	DE	19519947	GB	9511054	JP	8040146
US	4798967						
							END OF ANNEX

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patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

**Published:**

— *With international search report.*

## **DIRECT CURRENT MOTOR CONTROL CIRCUIT**

This invention relates to a vehicle mirror motor control used in moving a mirror between an in-use position and a parked position, in particular to a circuit which effectively turns off electric current to the motor as the mirror reaches the end of its intended travel when being folded back or moved to an operative position. However, it will be appreciated that such a circuit is useable in other apparatus which use electric motors and require an efficient and cost effective turn-off of the kind described.

## **BACKGROUND**

A side mounted vehicle rear view mirror is normally pivotally mounted to a vehicle mounting bracket so that it can be forwardly or rearwardly rotated relative to the vehicle. In an operative or in-use position it is located laterally of the vehicle body and in a folded or parked position is located approximately parallel to the side of the vehicle so as to prevent damage to the mirror and mirror housing. Such a folded position is useful when the vehicle is parked on narrow roadways or being taken through a car wash.

Motorised versions which fold mirrors in the manner described above are referred to as power fold mirrors and can be arranged with appropriate control electronics to move to a folded position when a button is pressed or upon the vehicle's ignition being turned off or alternatively the gear selector being placed in the parked position.

It is typical at this time for the motor used to drive the folding mechanism to be provided power until the current driving the motor is raised substantially above normal levels (over current) for a predetermined period of time. This can result from the mirror head coming against a stop. This manner of motor control is cheap to design, but not necessarily cheap to build and typically needs to include expensive

transient suppression components. An alternative is to use expensive and potentially unreliable limit switches.

Furthermore, periods of over current are an undesirable feature of prior power fold mirror designs as this can ultimately lessen the life of the electric motor and its associated drive train components or can cause unexpected failure. Yet furthermore, as the effects of spurious electromagnetic (EM) emissions are sometimes unpredictable, especially upon vehicle electronic systems, it is advantageous to eliminate or keep to an acceptable minimum this type of emission.

It is also typical that the motor used to drive powered mirrors are direct current (d.c.) motors which require a specific polarity of current to drive them in a desired direction and this tends to complicate the design of typical motor drive circuits.

It is an aim of this invention to eliminate or reduce the abovementioned problems.

## **BRIEF DESCRIPTION OF THE INVENTION**

In a broad aspect of the invention, a motor control circuit for a direct current electric motor having a pair of direct current inputs supplied respectively from negative and positive current sources wherein said motor is actuated to turn a shaft in one of two directions dependant on which polarity of current is being provided to said motor, said motor control circuit comprising,

a pair of unipolar control circuits wherein a respective one of each unipolar control circuits is connected between a respective current source and a current input to said motor wherein a respective unipolar control circuit which is adapted to operate said motor in one of said two directions,

a motor control circuit according to claim 1 wherein each of said unipolar control circuits are substantially identical.

a motor control circuit according to claim 1 wherein each of said unipolar control circuits further comprises,

a solid state switch located between a said motor current input and said source of direct current wherein the degree to which said solid state switch allows current to flow to said motor is controlled by an input bias signal to said switch,

current limiting means for adjusting said input bias signal according to the current flowing through said motor, such that said switching means adjusts said input bias to said solid state switch such that less current flows through said motor when a predetermined period of current limiting has occurred, and

a motor control circuit according to claim 3 wherein said current limiting means further comprises a temperature compensation circuit.

Specific embodiments of the invention will now be described in some further detail with reference to and as illustrated in the accompanying figures. These embodiments are illustrative, and not meant to be restrictive of the scope of the invention. Suggestions and descriptions of other embodiments may be included but they may not be illustrated in the accompanying figures or alternatively features of the invention may be shown in the figures but not described in the specification.

## **BRIEF DESCRIPTION OF THE DRAWINGS**

Fig 1 depicts a functional block diagram of a motor control circuit according to one embodiment of the invention, incorporating a circuit for each direction of motor operation;

Fig 2 depicts a circuit of both unipolar circuits for controlling the motor;

Fig 3 depicts the portion of one of the unipolar circuits which is functional during normal running of the motor as it actuates the motor between a first and second position;

Fig 4 depicts the portion of one of the unipolar circuits which is used to limit the current provided to the motor as well as temperature compensate the current limiting function; and

Fig 5 depicts the portion of one of the unipolar circuits which is used to abruptly cut off current to the motor after a period of current limiting.

#### **DETAILED DESCRIPTION OF AN EMBODIMENT OF THE INVENTION**

Fig 1 depicts a functional block diagram of a motor control circuit which has been found useful to control a motor used to actuate the folding and un-folding of a mirror housing between an extended and folded position.

However, any motor which has the task of moving an element between two positions could be controlled by such a circuit. Thus, even though the description provided herein is directed to vehicular outside rear view mirrors and their fold back function, the circuit is capable of being applied to motors required to provide similar movement.

The motor 10 is located between a positive (+) and negative (-) source of electrical current and dependent on the polarity of current applied to the motor the shaft of the motor will turn in a predetermined direction. Thus to change the direction of the motor, the supply current polarity is swapped, which can be easily done by controlling the position of a vehicle driver-operated switch or switch-like device (not shown).

In the example of an outside rear view mirror housing which is foldable relative to the vehicle body between a folded position and a lateral position, a single electric motor can be connected to a mechanical means for translating the rotational motion of the motor's shaft into a movement of the mirror housing between the described positions.

In the past when the mirror housing reached the end of its travel, the motor, which is controlled with a dual polarity control circuit, would draw large amounts of current until the relatively high current being drawn was detected and used to trigger the cut-off of the supply current.

As will be provided in more detail in this application, the described embodiment of the invention illustrates features which simplify and facilitate an alternative way to control an electric motor in this example as used in a foldable vehicular outside rear view mirror.

In this invention there is use of a novel topology which includes two unipolar electronic circuits. The motor is always in circuit whether the polarity is positive or negative and the motor drive circuits are symmetric.

Also, in this invention, one approach is to switch off current to the motor after current to the motor has been limited to a maximum level for a predetermined time.

However, this is but one preferred characteristics of the motor control arrangement for determining when to switch off or substantially reduce power to the motor.

In the preferred embodiment of this invention, the circuit used to sense electric motor current usage is by way of sensing the drop of voltage across a shunt resistor with a bipolar transistor which will turn on at a predetermined voltage level.

Fig 1 depicts two unipolar circuits one each side of the motor 10. Only one side of the circuit diagram will be described as the other side is identical. The opposite side of the circuit comes into operation upon a change of the polarity of the source current. However, it will be apparent that there is always a conduction path



through the opposite side to that which is operational so as to complete the circuit back to the current source.

A solid state switch 12 is located between one of the current inputs 14 of the motor 10 and the current source.

This switch 12 is used to control the amount of current which flows through the motor as well as to switch off current to the motor once a predetermined position or the end of travel has been reached, as is the typical case or when a switch off characteristic is detected.

A current limiting circuit 16 is located between the switch 12 and the source of current, in this case a positive current terminal. To provide consistency of operation over a reasonable environmental temperature variation, a temperature compensation circuit 18 is provided, but this is an option rather than a necessity for the operation of such a motor in the majority of circumstances.

During normal operation of the motor, the switch 12 is controlled by bias control circuit 20 which ensures that the switch is set so as to pass current directly to the motor 10.

Once the mirror housing or element actuated by the motor has reached the end of its travel a prompt cut-off of current to the motor is desirable and cut-off circuit 22 performs this function based on a predetermined period of active current limiting which is provided by circuit 16 once the end of travel is approaching or reached.

In one example, when the motor is detected drawing much more current than is required to drive the motor and a predetermined threshold current is exceeded for a predetermined time, motor current switch off is initiated.

Fig 2 depicts a complete circuit for a foldable vehicular external rear view mirror housing motor RM. The circuit is substantially symmetric so that one side can operate when one polarity of current is applied and other side can operate when the opposite polarity of current is applied. The common components being R1 and R2.

Fig 3 depicts those components of the circuit which are primarily active during the application of current such that terminal X4 has a positive polarity and the motor RM is running.

Current flows through the diode of Q4 (a parasitic diode which is available in transistors of this general type), through the motor RM, through Q1 and through current sense resistors R8 and R9. This diode provides reverse current blocking and over voltage protection but in other circuit configurations, a Zener diode of suitable characteristics could be across the output devices. In the preferred embodiment solid states switches Q1 and Q4 are each a Metal Oxide Silicon Field Effect Transistor (MOSFET) semi-conductor transistor device.

Switching transistor Q1 is the same as Q4 and is biased into conduction through its source and sink by a voltage supplied via D1, R1, R2 and R4. This voltage is sufficient to turn-on Q1 so that sufficient current can flow through the motor to drive the mechanism to which it is mechanically coupled.

It is merely preferable that current limiting is provided in this circuit configuration as it is equally possible to not have current limiting and allow the current to be controlled by the motor. For example, it is possible to detect the

magnitude of the current being drawn and if the magnitude exceeds a predetermined level for a predetermined time, initiates switch off of the current. Both approaches rely on the motor current wherein detection is the same but one also limits the current.

Fig 4 depicts those particular components of the circuit which are primarily active during the function of limiting current through the motor, but this is incidental to the end of travel detection.

Thus for the current limiting approach during normal operation, the current through R8 and R9 is such that the base voltage on Q3 is insufficient to cause Q3 to conduct between its collector and emitter. However, as the level of current flowing through the motor increases, the voltage on the base of Q3 increases and Q3 will begin to turn-on and conduct. As Q3 conducts more current, there is a reduction of on-bias of the main current switch Q1 via R4. Q1 thus conducts less current and current to the motor RM is thereby limited.

It is preferable however that the current limiting process be substantially consistent even with fluctuating temperature. Temperature compensation can be provided to accommodate a drive voltage of the main bipolar transistor Q1 which changes by approximately -1% for every +3°C.

In this embodiment collector current Q3 is provided via a thermistor R2 which has a negative temperature co-efficient. Thus as the ambient and component temperature rises, the current through the thermistor increases and the collector current through Q3 increases which partly off-sets the falling base voltage in Q3.

The increase in current through the thermistor R2 with increasing temperature will cause an increased voltage across R7. This voltage reduces the voltage

appearing across the base emitter junction of Q3. The effect is to off-set the reduction in base emitter voltage required by Q3 with increased temperature. R7, R2 and R1 are chosen to give a best fit current versus temperature curve. R1 limits the maximum current that can flow when very high temperatures are experienced by the system. It is worth noting that temperature compensation can be used to produce other than flat responses to accommodate for material softening etc in the mechanics.

Referring to Fig 5, when current limiting is occurring, the voltage across the solid state switch Q1 increases, hence reducing the voltage across the motor and with it the current. As the voltage across Q1 increases it also charges C1 via R3. Over a period of time C1 charges to a voltage such that Q2 turns-on and begins to conduct which in turn reduces the drive voltage of the main transistor solid state switch Q1.

This process accelerates as the period of current limiting increases and as current is reduced further the voltage across Q1 increases but raises the relative level of the base voltage on Q2 which in turn conducts more and thus brings down sharply the bias voltage applied to the main bi-polar transistor solid state switch Q1. This condition quickly reduces to substantially zero the conduction through Q1 and thereby the current flow which operates the motor.

R4 is chosen to keep to a minimum the current drawn by the circuit while Q1 is in the off-state.

With the exception of small bias currents, all primary current paths are conducted through the motor which is advantageous since transient voltage excursions from the supply are limited by the resistance and induction of the motor windings. A consequence of this design feature is that there is a reduced need for transient protection components.

A further advantage of the preferable circuit design, is the use of current limiting and the period of current limiting being used to determine the cut-off condition for current flowing through the motor. This is likely to result in less stress (mechanical and electrical) upon the motor when the mechanism to which it is connected reaches the end of its travel and also improves the Mean Time Between Failure (MTBF) of the motor actuated element.

A yet further advantage of the preferable circuit is the small quiescent current drawn once the MOSFET switch is turned off as indicated in relation to the selection of the value of R4.

Even though the circuit is arranged to detect an increasing current condition through the motor it does not necessarily know if this condition has occurred because the mechanism it actuates has actually reached one of its end of travel positions. Such a condition could occur if the mechanism is stopped unexpectedly intermediate its end of travel positions. Other sensors and circuits can then be used to ensure that the intended end of travel position has in fact been reached but these issues are not central to the problem addressed by the invention disclosed in this specification.

It will be appreciated by those skilled in the art, that the invention is not restricted in its use to the particular application described and neither is the present invention restricted in its preferred embodiment with regard to the particular elements and/or features described or depicted herein. It will be appreciated that various modifications can be made without departing from the principles of the invention, therefore, the invention should be understood to include all such modifications within its scope.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A motor control circuit for a direct current electric motor having a pair of direct current inputs supplied respectively from negative and positive current sources wherein said motor is actuated to turn a shaft in one of two directions dependant on which polarity of current is being provided to said motor, said motor control circuit comprising,  
a pair of unipolar control circuits wherein a respective one of each unipolar control circuits is connected between a respective current source and a current input to said motor wherein a respective unipolar control circuit which is adapted to operate said motor in one of said two directions.
2. A motor control circuit according to claim 1 wherein each of said unipolar control circuits are substantially identical.
3. A motor control circuit according to claim 1 wherein each of said unipolar control circuits further comprises  
a solid state switch located between a said motor current input and said source of direct current wherein the degree to which said solid state switch allows current to flow to said motor is controlled by an input bias signal to said switch,  
current limiting means for adjusting said input bias signal according to the current flowing through said motor, such that said switching means adjusts said input bias to said solid state switch such that less current flows through said motor when a predetermined period of current limiting has occurred.
4. A motor control circuit according to claim 3 wherein said current limiting means further comprises a temperature compensation circuit.

5. A motor control circuit according to claim 4 wherein said temperature compensation circuit comprises a thermistor having a negative temperature coefficient located in said circuit so that as the ambient temperature and control circuit temperature rises the current through the thermistor increases and said input bias signal to said solid state switch is compensated.
6. A motor control circuit according to claim 3 wherein said switch means is arranged to not operate said motor when said current limiting is occurring for a further predetermined period of time.
7. A motor control circuit according to claim 3 wherein said switch means is arranged to not operate said motor when current drawn by said motor exceeds a predetermined threshold current for a predetermined period of time.
8. A motor control circuit according to claim 3 wherein said current limiting means comprises  
a motor current sensing circuit comprising a shunt resistor arranged to carry a proportion of the current flowing through said motor and provide a respective voltage to the base of a bipolar transistor which is arranged to turn on at a predetermined voltage level representative of the current flowing through said motor at which it should be switched off, such that said bipolar transistor turns on when said predetermined voltage level is reached and which decreases the input bias to said solid state switch to lessen the current through said motor.
9. A motor control circuit according to claim 1 wherein each of the other of said pair of unipolar control circuits conducts current to complete the circuit to allow said motor to operate.

10. A motor control circuit according to claim 1 wherein each of said unipolar control circuits further comprises

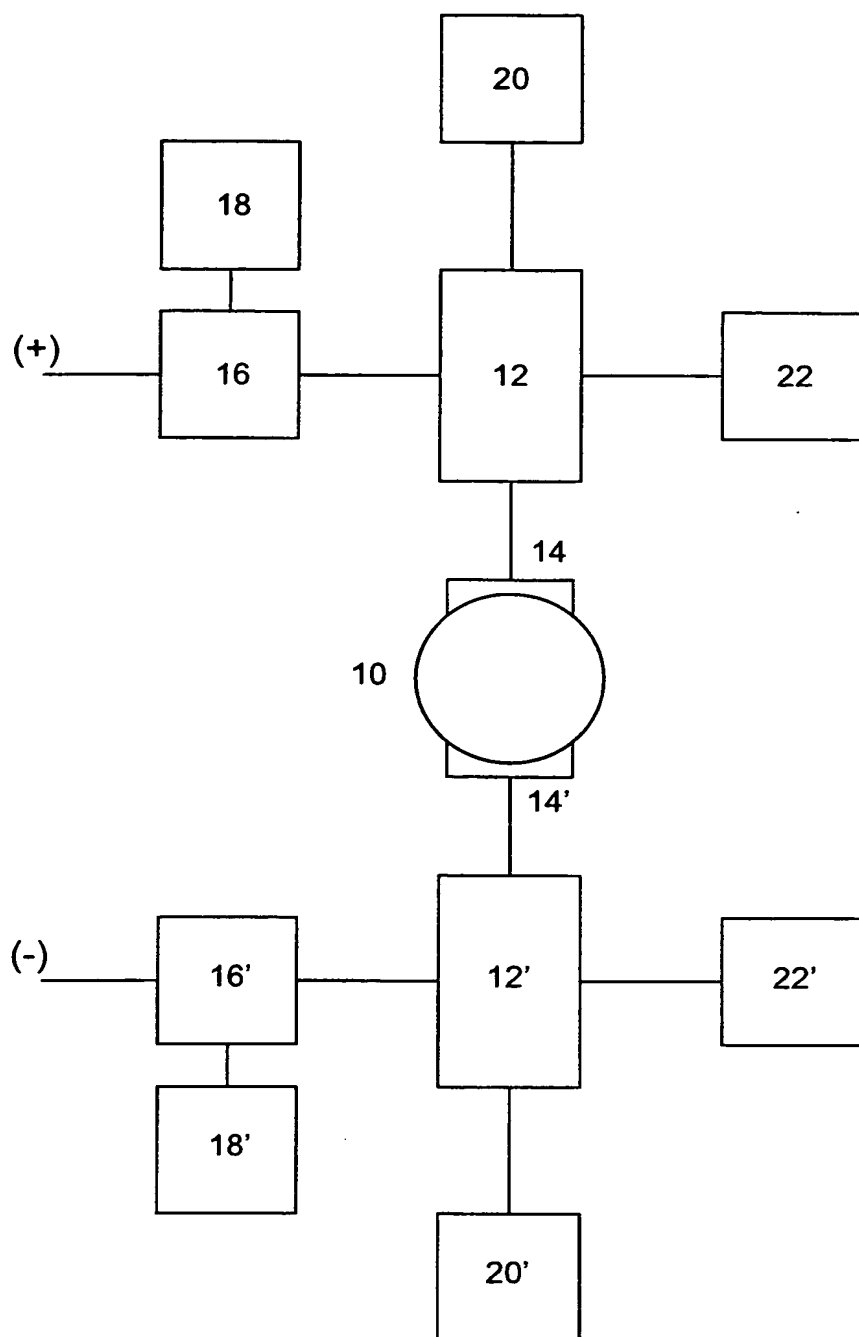
a solid state switch located between a said motor current input and said source of direct current wherein the degree to which said solid state switch allows current to flow to said motor is controlled by an input bias signal to said switch,

current detection means to detect the magnitude of current being drawn through said motor and if said magnitude exceeds a predetermined level for a predetermined time reduce said input bias signal to said switch.

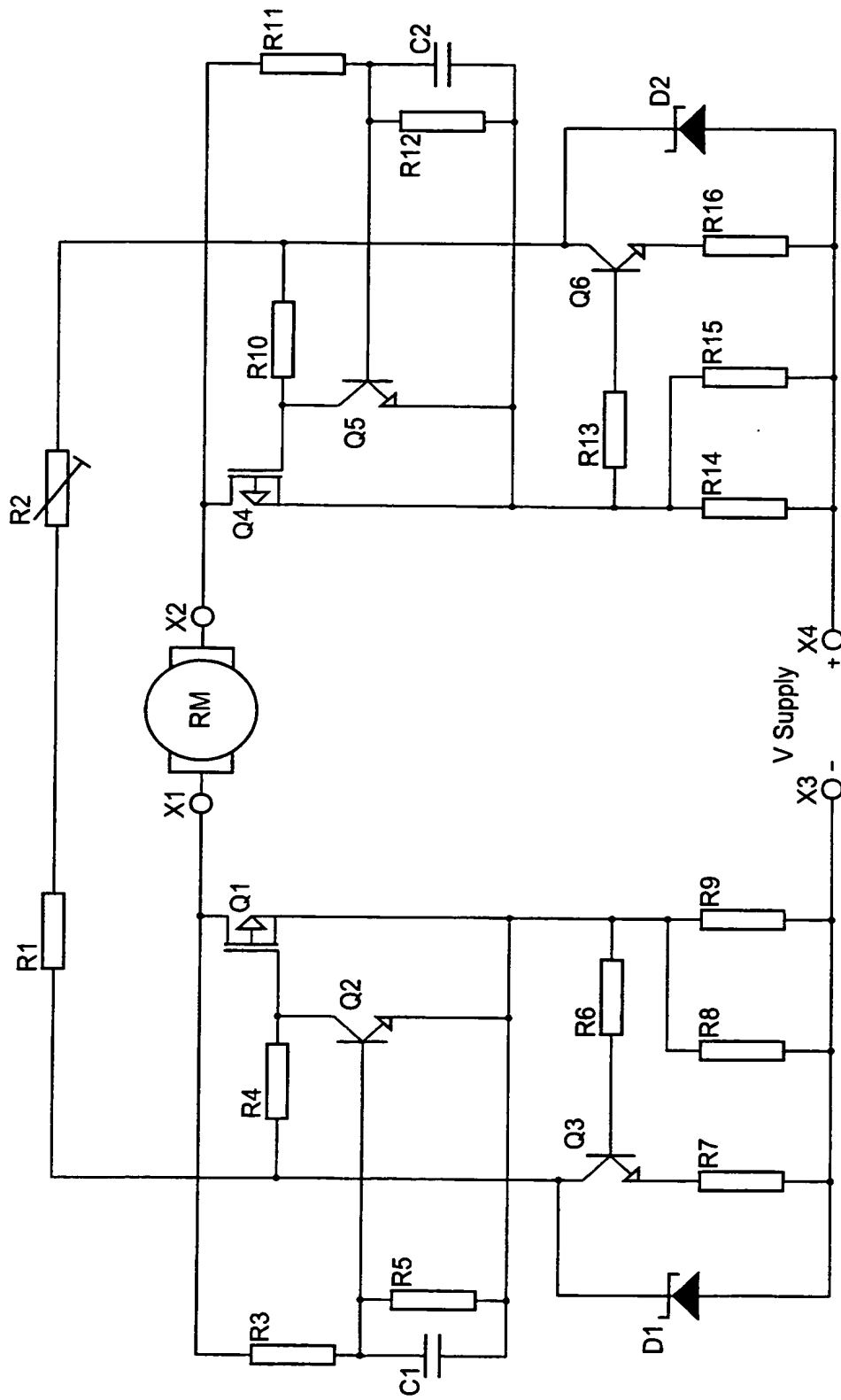
11. A motor control circuit according to claim 1 wherein current is primarily conducted through said motor.



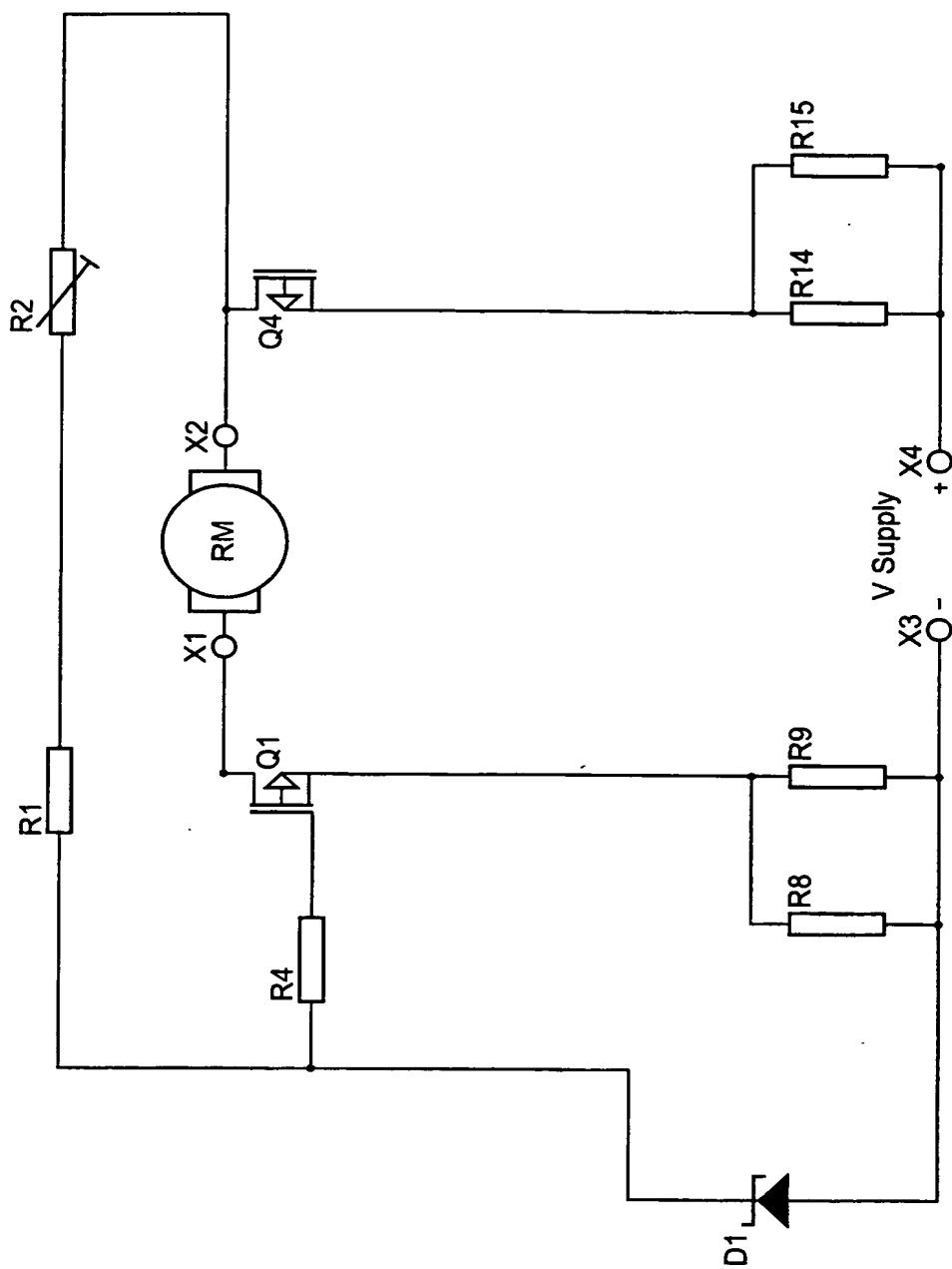
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**Fig 1**

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**Fig 2**

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**Fig 3**

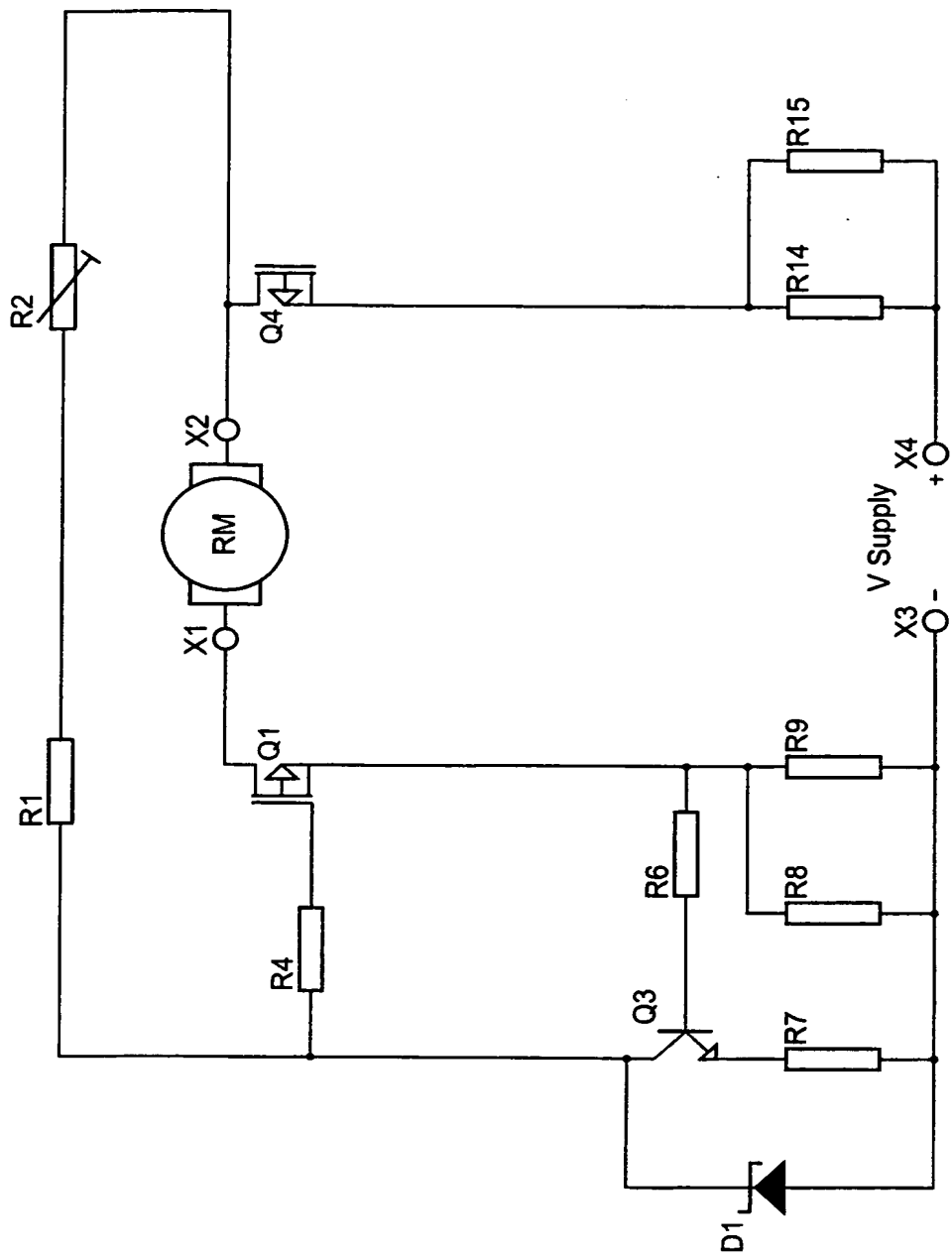
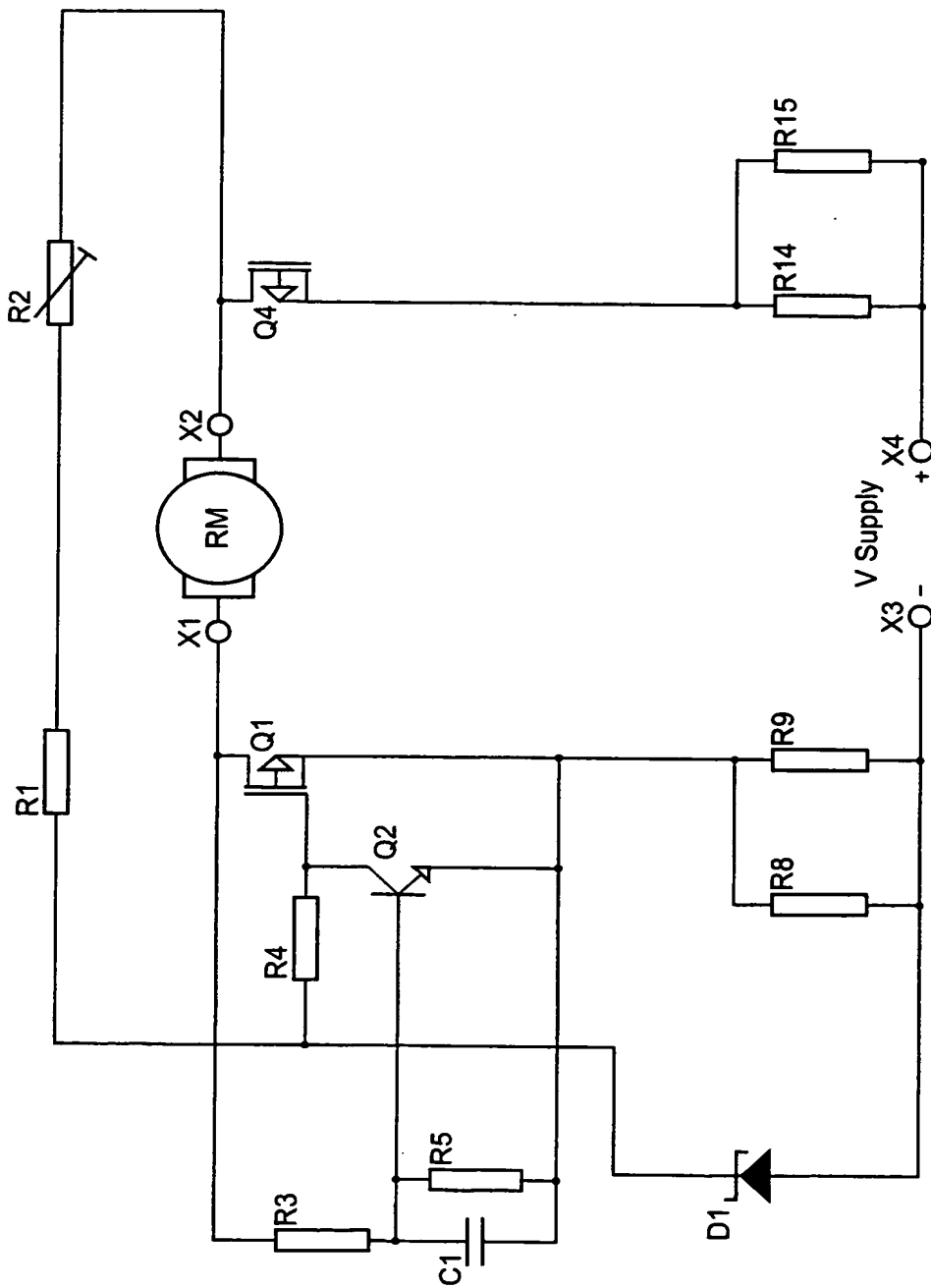


Fig 4

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**Fig 5**

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU00/01142

**A. CLASSIFICATION OF SUBJECT MATTER**Int. Cl. <sup>7</sup>: H02P 7/28; G05B 5/00

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

IPC: H02P /IC; G05B 5/IC; G02B 7/IC

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched  
IPC: AU AS ABOVE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPAT: Direct current, bidirection, unipolar, circuit, polar+, automo+, mirror+

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5,952,802 A (PIMLEY) 14 September 1999 ✓ Whole document	1-11
A	US 5,530,327 A (VECCHIARINO) 25 June 1996 ✓ Whole document	1-11
A	US 5,514,940 A (OKAMOTO) 07 May 1996 ✓ Whole document	1-11

☒ Further documents are listed in the continuation of Box C ☒ See patent family annex

<p>* Special categories of cited documents:</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier application or patent but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p>		<p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</p> <p>"&amp;" document member of the same patent family</p>
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Date of the actual completion of the international search

10 October 2000

Date of mailing of the international search report

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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4,798,967 A (YAMANA ET AL) 17 January 1989 Whole document	1-11

**INTERNATIONAL SEARCH REPORT**  
Information on patent family members

International application No.  
PCT/AU00/01142

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member					
US	5952802						
US	5530327	DE	69312889	EP	603509	JP	6206497
US	5514940	DE	19519947	GB	9511054	JP	8040146
US	4798967						
END OF ANNEX							